5.4. Ocean Projects

5.4.1. Data Analysis

Natural halocarbons are important contributors to the destruction of stratospheric ozone. For example, methyl bromide (CH_3Br) and methyl chloride (CH_3Cl) together are the source of about one-quarter of the equivalent chlorine in the troposphere [*Butler*, 2000], where equivalent chlorine is one way to evaluate the ozone-depleting capacity of the atmosphere [*Daniel et al.*, 1995]. Other brominated compounds, such as dibromomethane (CH_2Br_2) and bromoform ($CHBr_3$), also might be significant sources of bromine to the upper atmosphere [e.g., *Schauffler et al.*, 1999; *Sturges et al.*, 2000]. An understanding of the sources and sinks of these compounds would enable the prediction of changes in the cycling of these compounds associated with climate change. Because the oceans are both a source and a sink of most natural halocarbons, oceanic measurements have constituted one component of the HATS group research effort.

Data obtained from previous field missions were analyzed during 2000-2001. The variability in sea surface temperature (SST) has been shown to account for one-half to two-thirds of the variability in methyl bromide oceanic saturations, according to *King et al.* [2000]. In that study, data from six cruises were fitted with two quadratic equations. While global extrapolations with this relationship appear reasonable, this relationship does not accurately reproduce observations on a regional basis. However, reexamination of the data, along with inclusion of data from a 1999 expedition to the Pacific Ocean, has significantly improved the ability to reproduce field observations.

Data from seven research cruises (five conducted by CMDL and two by Dalhousie University) were divided seasonally into two data sets: spring-summer and fall-winter. These data include measurements from the Atlantic [*Lobert et al.*, 1996; *Groszko and Moore*, 1998; *King et al.*, 2000], the Pacific [*Lobert et al.*, 1995; *Groszko and Moore*, 1998; *King et al.*, 2000; unpublished CMDL data], and the Southern Ocean [*Lobert et al.*, 1997]. Measurements made between March 20 and September 21 were considered spring-summer if north of the equator and fall-winter if south of the equator. Data collected during the remainder of the year were assigned to fall-winter if north of the equator and spring-summer if south of the equator. Each seasonal data set was fitted with two quadratic equations, describing data above and below 16°C (Figure 5.33).

The new equations represent a significant improvement over the existing equations, particularly in temperate regions. For example, the previous equations could account for only about 15% of the seasonal difference (summertime supersaturations and fall undersaturations) in CH_3Br saturation anomaly observed in the North Atlantic temperate waters [*King et al.*, 2000]. However, the new equations can reasonably reproduce the observed seasonal difference for CH_3Br in these waters. The seasonal SST relationships also improve the ability to estimate the mean saturation anomaly for a given data set. For the two most recent cruises, Gas Exchange Experiment (Gas Ex 98) [*King et al.*, 2000] and Bromine Air-sea Cruise Pacific (BACPAC 99) [*Schnell et al.*, 2001], the mean CH_3Br saturation

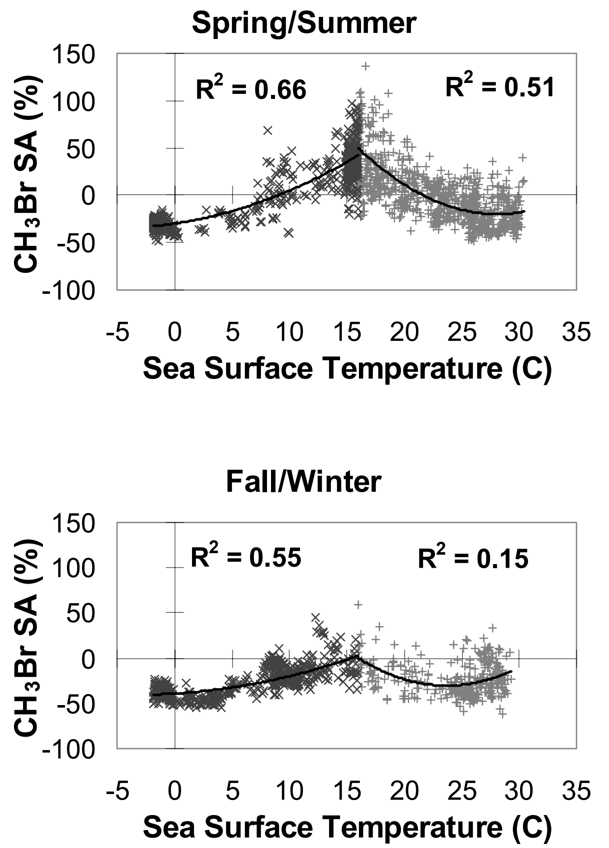

Fig. 5.33. Methyl bromide saturation anomaly data from five CMDL cruises and two Dalhousie University cruises between 1994 and 1999, plotted as a function of sea surface temperature. The data are divided seasonally, with local spring and summer data in the upper plot and local fall and winter data in the lower plot. Quadratic fits are used to describe data above and below 16°C for each seasonal data set.

anomalies estimated with the new equations are about 90% of the measured values. In contrast, the mean saturation anomalies as determined with the old equations [*King et al.*, 2000] are only about 60% of the measured values.

Methyl bromide saturation anomaly maps have been generated with the seasonal SST relationships and a global map of SSTs (Figure 5.34). The SST data set consists of 1° × 1° monthly means from the National Oceanographic Data Center (NODC) [*Levitus*, 1982]. Each grid point represents a 3-mo average value. In this model CH_3Br under-saturations are predicted in both the tropics and polar regions throughout the year. The temperate waters, however, show a strong seasonal cycle in both hemispheres. With the data used to create these maps, the global, annually averaged CH_3Br saturation anomaly is calculated to be −15.5%. The calculated global, annually averaged CH_3Br flux is −19.9 Gg yr^{-1}. Both of these values agree with other published estimates [e.g., *Lobert et al.*, 1997; *King et al.*, 2000].

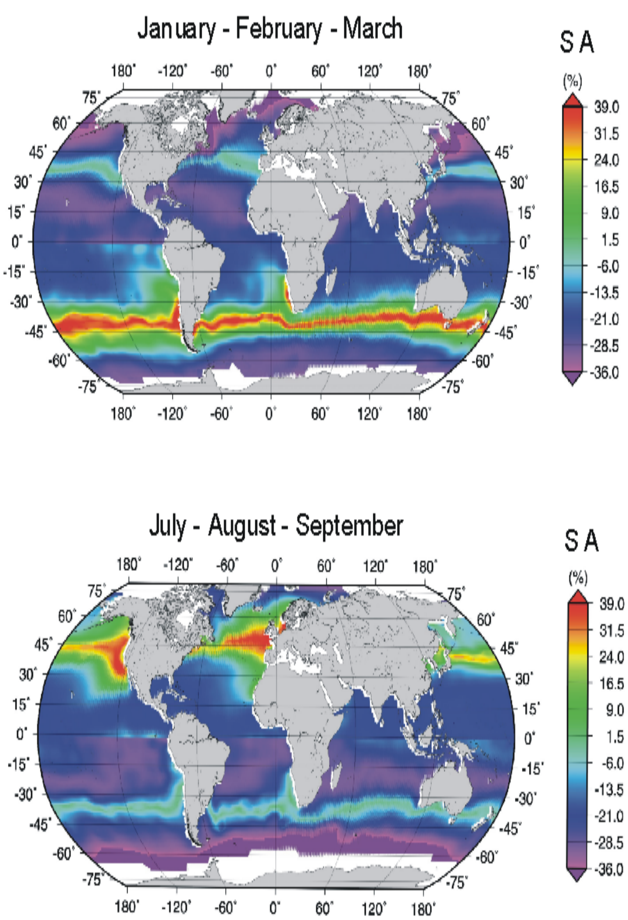

Fig. 5.34. Methyl bromide saturation anomalies plotted as 3-mo averages on 1° by 1° grid size. These maps were generated with relationships between saturation anomaly and sea surface temperature (shown in Figure 5.33). White spaces represent regions with insufficient sea surface temperature data to calculate a value for the CH_3Br saturation anomaly.